Three new species of the genus *Cheilea* from the Atlantic Ocean (Gastropoda: Hipponicidae)

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ABSTRACT

Individuals from populations previously thought to represent *Cheilea equestris* (Linnaeus, 1758) are studied, showing that they belong to diffferent species. Three new species are described and named herein: one from the eastern Atlantic, another from the western Atlantic and a third one with amphiatlantic distribution. A lectotype for the type species of the genus is designated.

INTRODUCTION

Since the latter half of the 20th Century, the genus *Cheilea* Modeer, 1793 underwent several changes both in taxonomic status and systematic position: Thiele (1929) and Wenz (1940) placed it in Amaltheidae (= Hipponicidae); Kuroda (1941) in Calyptraeidae; Ludbrook (1941) in the family Cheileidae Macpherson and Chaple, 1951, superfamily "Cheileacea." Iredale and McMichael (1962) and Kuroda et al. (1971) kept it in Cheileidae. Rehder (1980) placed it in Crepidulidae. Vaught (1989) and more recently Bouchet and Rocroi (2005) placed it in the family Hipponicidae Troschel, 1861.

Linnaeus (1758) described the species *Patella equestris* from the Indian Ocean. His types, deposited at the Linnean Society (Figures 1–3) seem to belong to two distinct species, but they do not bear detailed locality data. Moreover, they are difficult to study due the erosion of their protoconch.

Linnaeus mentioned "O. Indico" as the type locality for the species; despite that, several populations from different areas and oceans have been associated to the name *Cheilea equestris*. We list some of them herein:

Indo-Pacific: California to Chile (Abbott, 1974); Red Sea (Sharabati, 1984); Japan (Fukuda, 1990); India (Subba Rao, 2003); China, Japan, Philippines (Zhongyan, 2004); E. Pacific, Indo-Pacific (Rios, 2009); Easter Island (Rehder, 1980); Hawaii (Severns, 2011).

Atlantic: Florida, West Indies and Brazil (Abbott, 1974); Yucatan, Mexico (Vokes and Vokes, 1983); Caribbean Dutch islands (de Jong and Coomans, 1988); Florida, West Indies, Brazil: Amapá to Espírito Santo, Fernando de Noronha Archipelago, Davis Seamount (Leal, 1991); São Tomé and Principe (Fernandes and Rolán, 1993); Bahamas (Redfern, 2001); Brazil, West Atlantic, Canary, Madeira, Ascension (Rios, 2009); Cape Verde Archipelago (Rolán, 2005). Some records for Canary and Madeira (Cosel, 1982) have not been confirmed by later general works.

Pantoli and Riggieri (1988) mention the species for the Italian Pliocene and consider it to be a cosmopolitan species.

Espinosa and Ortea (2011) described a new genus (*Milicheilea*) with shells similar to that of a *Cheilea* but smaller and having a very large internal prominence. The protoconch is apparently similar and it should be studied before acceptance of a distinct genus, as the internal prominence may be induced by the environment (for example, if the animal lives in cavities resulting in a wide shell to keep the body closed and occluded, or in acid environments that can dissolve the external shell while the internal one is protected by the soft parts).

Study and comparison of specimens from some of these populations have shown that they represent different species, which are similar in general external appearance only. Some of these species are described as new in the present paper.

MATERIALS AND METHODS

Descriptions of protoconch morphology follow the methodology and nomenclature described by Verduin (1986). Sex of some individuals in this study was inferred based on attachment of smaller males to the shells of females (Redfern, 2001: 48, fig. 206A) Institutional and other abbreviations used are: AMNH, American Museum of Natural History, New York, USA; BMSM, The Bailey-Matthews Shell Museum, Sanibel, Florida, USA; IES, Instituto de Ecología y Sistemática, Havana, Cuba; LS, Linnean Society, London, UK; MHNS, Museo de Historia Natural, Santiago de Compostela, Spain; MNCN, Museo Nacional de Ciencias Naturales, Madrid, Spain; MNHN, Muséum national d'Histoire naturelle, Paris, France; MNRJ, Museu Nacional/Universidad Federal,

Rio de Janeiro, Brazil; NHMUK, Natural History Museum United Kingdom, London, UK; CCR, collection of Colin Redfern, Boca Raton, Florida, USA (recently incorporated to BMSM); CFG, collection of Raúl Fernández-Garcés, Cienfuegos, Cuba; CPR, collection of Peter Ryall, Maria Rain, Austria; CSG, collection of Sandro Gori, Livorno, Sicily, Italy; lv, live-collected; s, empty shell; j, juvenile.

SYSTEMATICS

Family Hipponicidae Troschel, 1861

Genus *Cheilea* Modeer, 1793

Cheilea Modeer, 1793: 110.
Mitrularia Schumacher, 1817: 56.
Litliedaphus Owen, 1843: 147.
Calyptra H. Adams and A. Adams, 1854: 364.

Type Species: *Patella equestris* Linnaeus, 1758, by subsequent designation (Modeer, 1793)
Cheilea equestris (Linnaeus, 1758)
(Figures 1–8)

Patella equestris Linnaeus, 1758: 780; "O. Indico."

Type Material: In LS (A-F 0020204). Lectotype here designated (Figures 1–3).

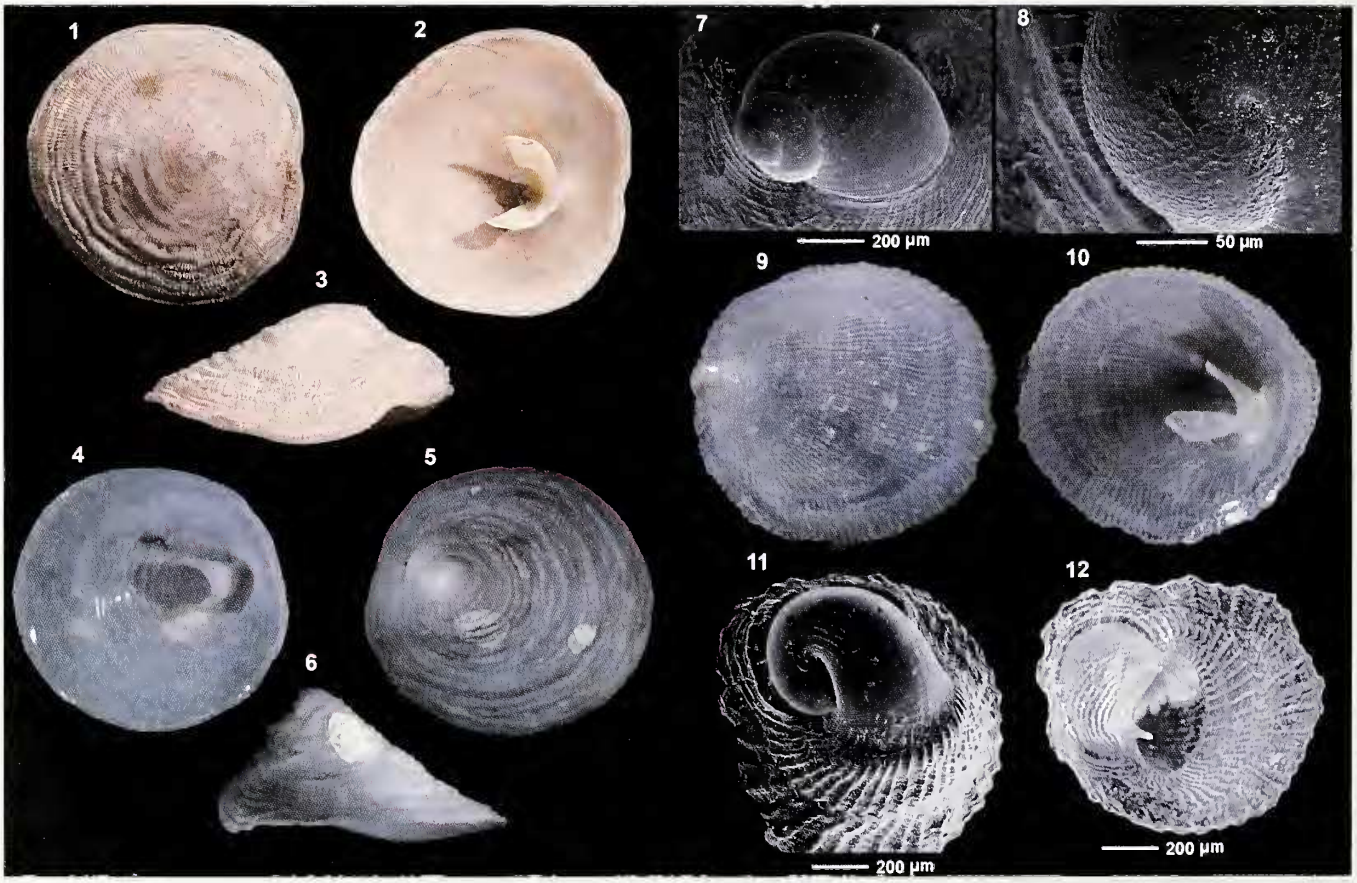
Original Description: *"P. testa integra orbiculata, labio fornicali perpendiculari".*

Description: Shell cap-shaped, usually very irregular, with rugose, axial sculpture. Internally with an erect and flat curved process that begins under apex. Protoconch (Figures 7–8) with 1.75 whorls, the first 0.75 whorl with slightly rough surface, followed by smooth surface. Protoconch about 600 µm in maximum diameter. Rest of surface smooth. Teleoconch begins with about 25–35, very fine spiral lines.

Dimensions: About 37 mm in maximum diameter.

Distribution: *Cheilea equestris* has been considered to be a cosmopolitan species. Further studies may well show that it comprises a complex of several similar-looking species.

Lectotype Designation: In the LS collection the type material from Linnaeus evidently includes two different species. We have selected as the **lectotype** (Figures 1–3)



Figures 1–12. *Cheilea* species. **1–6.** *Cheilea equestris* (Linnaeus, 1758). **1–3.** *Patella equestris* Linnaeus, 1758. **Lectotype** selected from the material in the LS (A-F 0020204), 37 mm in diameter (Indian Ocean). **4–6.** Bali, 37.8 mm (MHNS). **7–8.** *Cheilea* cf. *equestris*, Panglao, Philippines (MHNS). **9–12.** *Cheilea striata* Nowell-Usticke, 1959. **9–10.** Juvenile, 1.5 mm, Abaco, Bahamas (CCR). **11–12.** juvenile with protoconch, 12.5 mm, Cienfuegos, Cuba (MHNS).

the shell that most closely agrees with the description and shells usually associated with the nominal species.

Remarks: The type locality is Indian Ocean. The Linnean material is badly eroded, so that the protoconchs could not be examined. We have presented (Figures 4–6) a shell from Bali (Indonesia) with the same diameter of the lectotype and with part of the protoconch preserved. This is similar to the protoconch of a juvenile from Philippines (Figures 7–8).

Cheilea striata Nowell-Usticke, 1959
(Figures 9–12)

Cheilea equestris striata Nowell-Usticke, 1959: 47, pl. 2, fig. 19. [Type locality: Judith's Fancy, St. Croix, U.S. Virgin Islands, Atlantic Ocean].

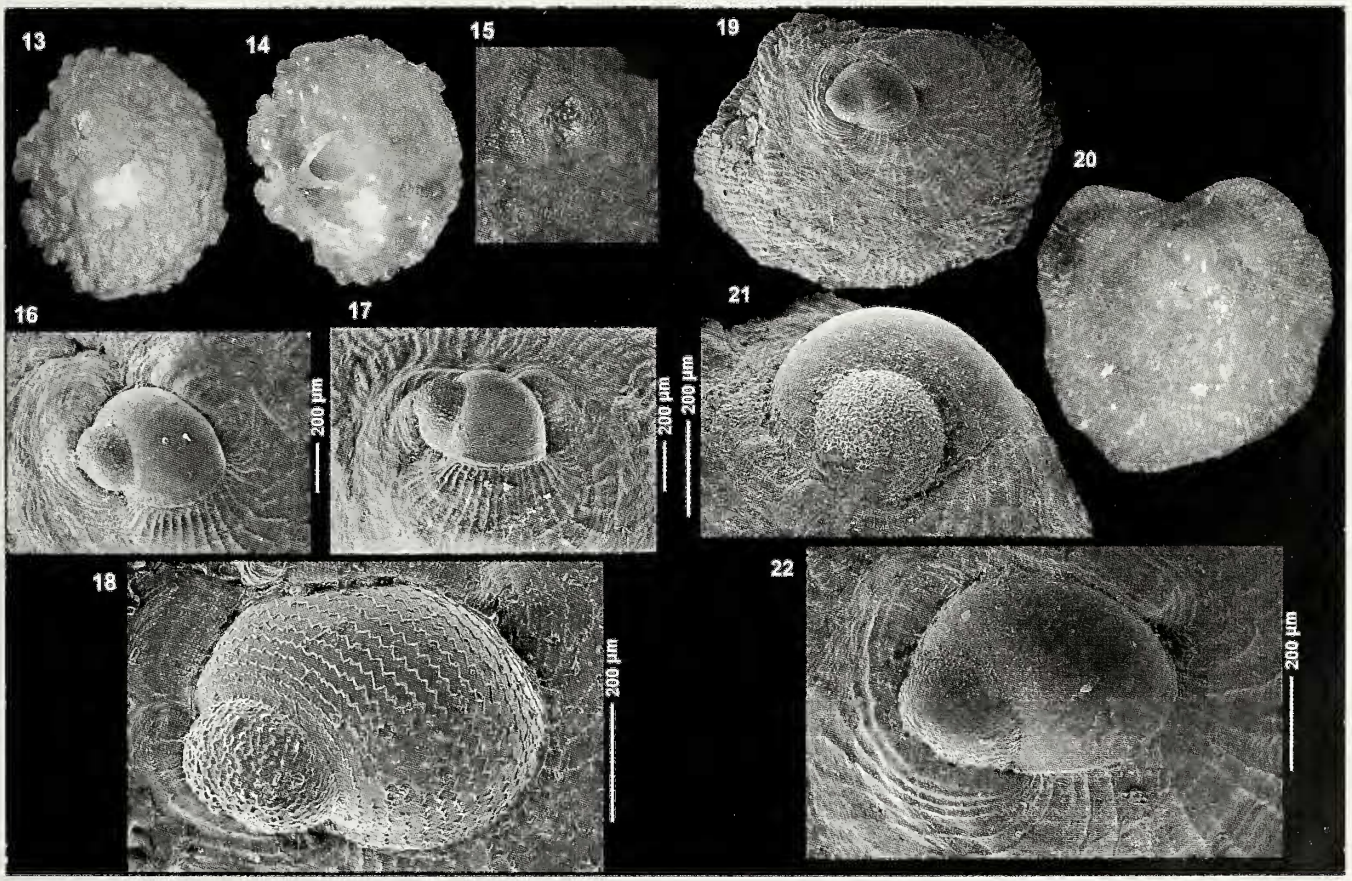
Type Material: Holotype: AMNH (198509). Paratype: AMNH 294373 (1 specimen). Not examined.

Other Material Examined: Cuba: 2 s, 2 j, Rancho Luna, Cienfuegos, 10-20 m (MHNS). Bahamas: 3 j, Abaco, 10 m (CCR).

Description: The protoconch (Figures 11–12) has only one whorl, the nucleus is wide, more than 250 µm and the entire protoconch is about 600–700 µm in diameter, with very fine spiral lines. The teleoconch is similar, with numerous radial striae crossed by isolated concentric lines.

Distribution: Known from the Virgin Islands (type locality), Bahamas, and Cuba.

Remarks: Nowell-Usticke (1959) described this species as a "form" having "strong raised radiating ribs roughly equal in size. On some shells these radiating ribs cross rather weak concentric lines". Nowell-Usticke (1959) referred to material ex-Usticke Collection (AMNH 198509) and Schwartz Collection (AMNH 294373). The repository of additional paratypes is unknown; its existence is indicated by Usticke (1959: 47) and the size range for the taxon is given as 20–40 mm length. Faber (1988: 90) considered this taxon to be a synonym of *C. equestris* (Linnaeus, 1758); we cannot agree with this view due to the consistent differences in protoconch morphology.



Figures 13–22. *Cheilea americana* new species. **13.** Holotype (female) (BMSM 17939) and paratype (male) on the dorsum, 19 and 7 mm, Abaco, Bahamas, ex-CCR. **14.** Ventral view. **15.** Male on the dorsum of the female shell. **16.** Protoconch of female (holotype). **17.** Protoconch of male (paratype). **18.** Protoconch of a juvenile, Abaco, Bahamas (CCR). **19.** Paratype, juvenile 2.4 mm, Rancho Luna, Cuba (MHNS). **20.** Paratype, juvenile, 3.5 mm, María la Gorda, W Cuba (MHNS). **21–22.** Protoconchs in two positions (Figure 21 from the shell of the Fig. 19).

Redfern (2001) illustrated the protoconch of Bahamian specimens externally and internally. These are very distinctive from the protoconch of *C. equestris*. Shells from Cuba are equal to those from Bahamas. Other species of this genus can be distinguished by their distinctive protoconchs.

***Cheilea americana* new species Rolán, Redfern, and Fernández-Garcés**
(Figures 13–18, 42–43)

Type Material: Holotype (female, sp) and a paratype (male, sp) in BMSM (17939) (Figures 13–14). Other paratypes: MNCN (15.05/60102, 1 j); MHNS (100593, 1 j, Figure 16) both from Maria la Gorda, 10–15 m, W Cuba); MNCN (15.05/60103, 2 s); MNHN (IM-2012-2112, 3 j), CCR (2 j), CFG (2 s, 2 j) and IES (1 s, 1 j), all from Rancho Luna, 10–20 m, Cuba).

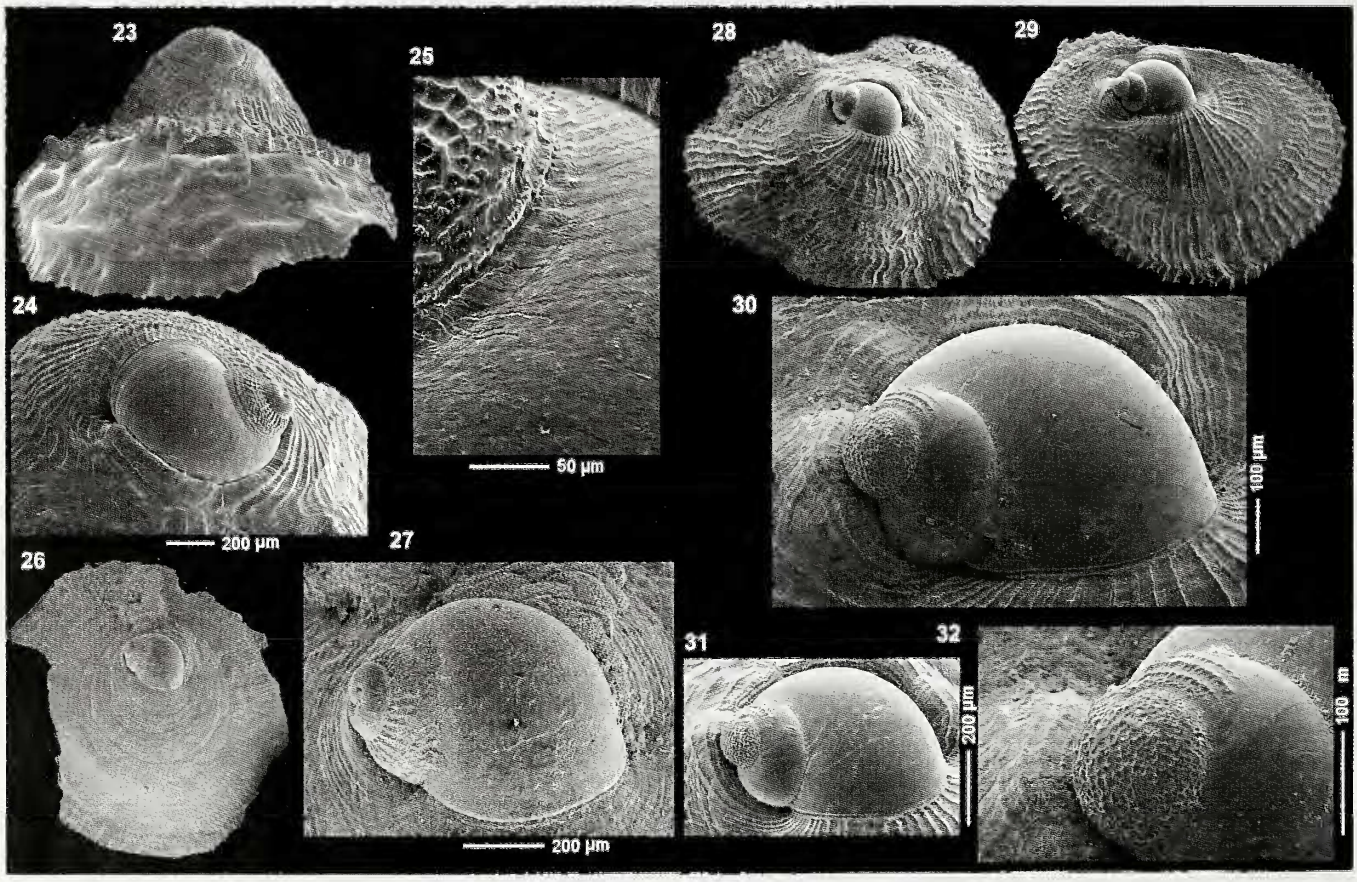
Type Locality: Reef off Great Guana Cay, 26°42′30″ N, 77°09′46″ W, Abaco, Bahamas, 4.5 m.

Etymology: The specific name refers to the continents off which the species was collected.

Other Material Examined: 1 sp, Chapéu Nordeste Island, Fernando de Noronha Archipelago, Brazil (MNRJ).

Description: Shell rather irregular, conical-depressed, as an inverted cup, whitish, with numerous radiating ribs. Protoconch (Figures 16–17) with 1.75 whorls, 530 µm in maximum diameter, nucleus about 100 µm. First 0.75 whorl very rough, subsequent whorl with zig-zag lines, often eroded (Figure 18). Initial part of the teleoconch with about 16–23 spiral cordlets; teleoconch expands quickly to partially envelop the protoconch. Rest of teleoconch very irregular, with prominences, undulating areas, and concentric scaly lines. Edge very irregular and inner surface with a prominence. Internally with an erect curved process, which begins under apex and is characteristic of genus.

Radula (Figures 42–43) with very wide rachidian teeth, each with very prominent central cusp and 8–9 smaller lateral cusps. Lateral teeth elongated, with about 5 cusps along cutting edge, most prominent one very large and wide; inner marginal teeth elongate, with wide and prominent cusp and 6–8 very small fine cusps on each side; outer marginal teeth similar to inner marginal teeth but narrower and with less cusps.



Figures 23–32. *Cheilea* species. **23–27.** *Cheilea atlantica* new species. **23.** Holotype, 7.2 mm, Montague Seamount, Brazil (MNRJ 25542). **24.** Protoconch. **25.** Detail of the microsculpture. **26.** Shell, 3.2 mm, Lagoa Azul, São Tomé I. (MHNS). **27.** Protoconch. **28–32.** *Cheilea africana* new species. **28–29.** Paratypes, 2.7, 2.57 mm, Regona, Cape Verde Archipelago (MHNS). **30–32.** Protoconch and detail.

Dimensions: Shell of female individual 19 mm in maximum diameter; male with 7 mm maximum diameter.

Distribution: Brazil, Bahamas, Cuba.

Remarks: *Cheilea equestris* has a more finely striated shell (Figures 1–3); the protoconch is larger (about 650 µm, Figure 7) and is less sculptured (Figures 7–8). For the differences with the other species see below.

***Cheilea atlantica* new species Rolán, Leal, and Fernández-Garcés**
(Figures 23–27)

Type Material: Holotype (Fig. 23) in MNRJ (25542). Paratypes: MNCN (15.05/60101, 1 s) from Santo Antonio de Palé, Annobon, Equatorial Guinea; MHNS (100594, 1 j, Figure 26) Lagoa Azul, São Tomé.

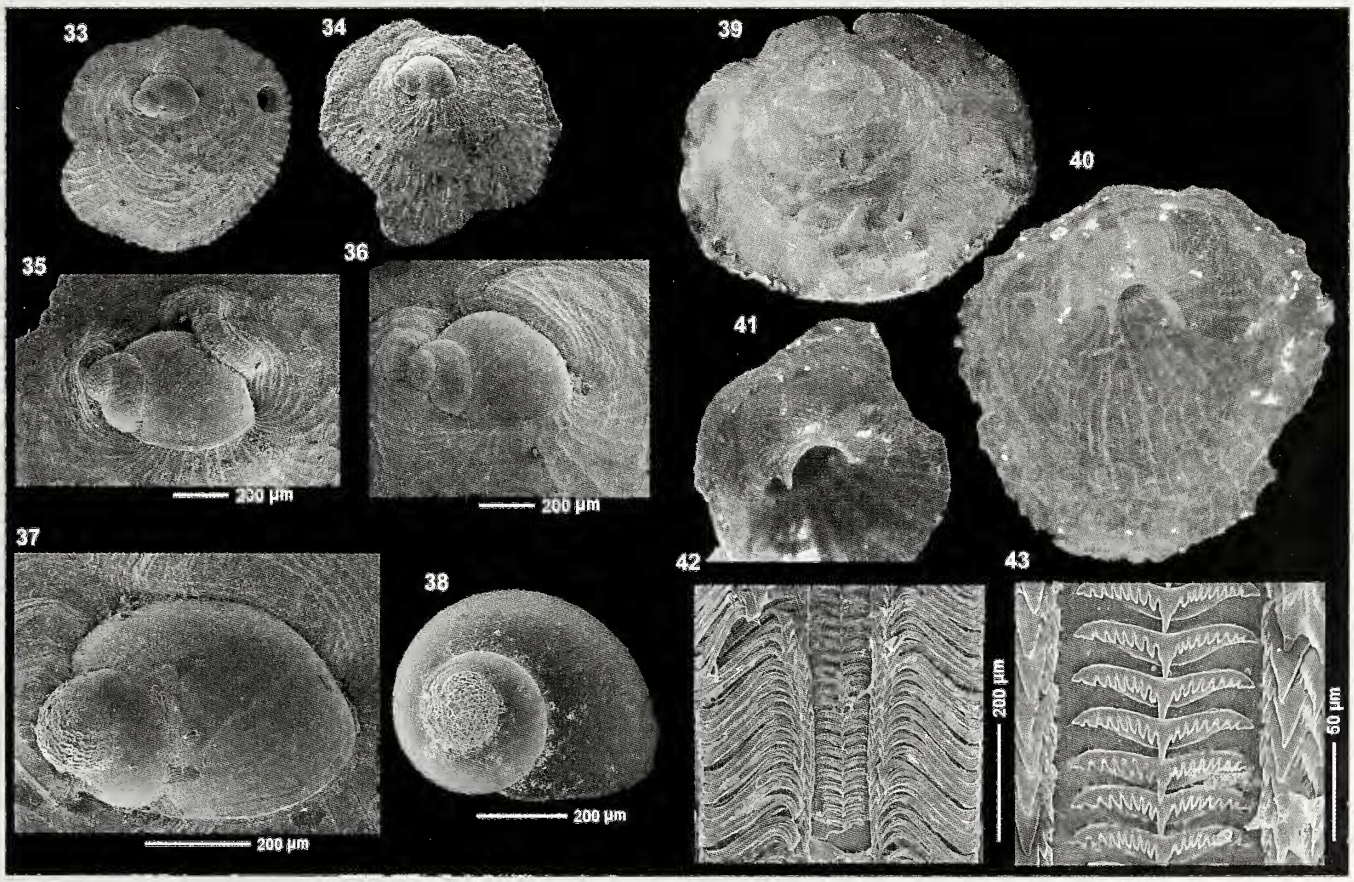
Other Material Examined: Cuba: 1 j, Rancho Luna, Cienfuegos, 10-20 m (MHNS).

Type Locality: Montague Seamount, Brazil.

Etymology: The specific name refers to the Ocean where the species was collected.

Description: Shell very irregular, approximately conical, solid, whitish with radial ribs. Protoconch (Figures 23, 27) with 2.75 whorls, maximum diameter 800 µm. Nucleus with about 130 µm. Nucleus and following 0.5 whorl lacking sculpture or only very lightly sculptured. Reticulated sculpture appears after nucleus and following 0.5 whorl. This lasts for 1.5 whorl. Last protoconch 0.5 whorl with very fine spiral striae and growth lines. Beginning of teleoconch with numerous (about 50–55) light spiral cordlets, which gradually separate: a group of these cordlets borders the protoconch on each side while others continue in front and centrally at the end last protoconch whorl. Internal shell surface with the erect and curved process, which begins under the apex and is characteristic of the genus.

Dimensions: Holotype 7.2 mm in diameter; a paratype (MNCN) reaches 11.7 mm in maximum diameter. The species may reach larger sizes, but one would need to see a complete shell with well-preserved protoconch ensure that it is actually the present species.



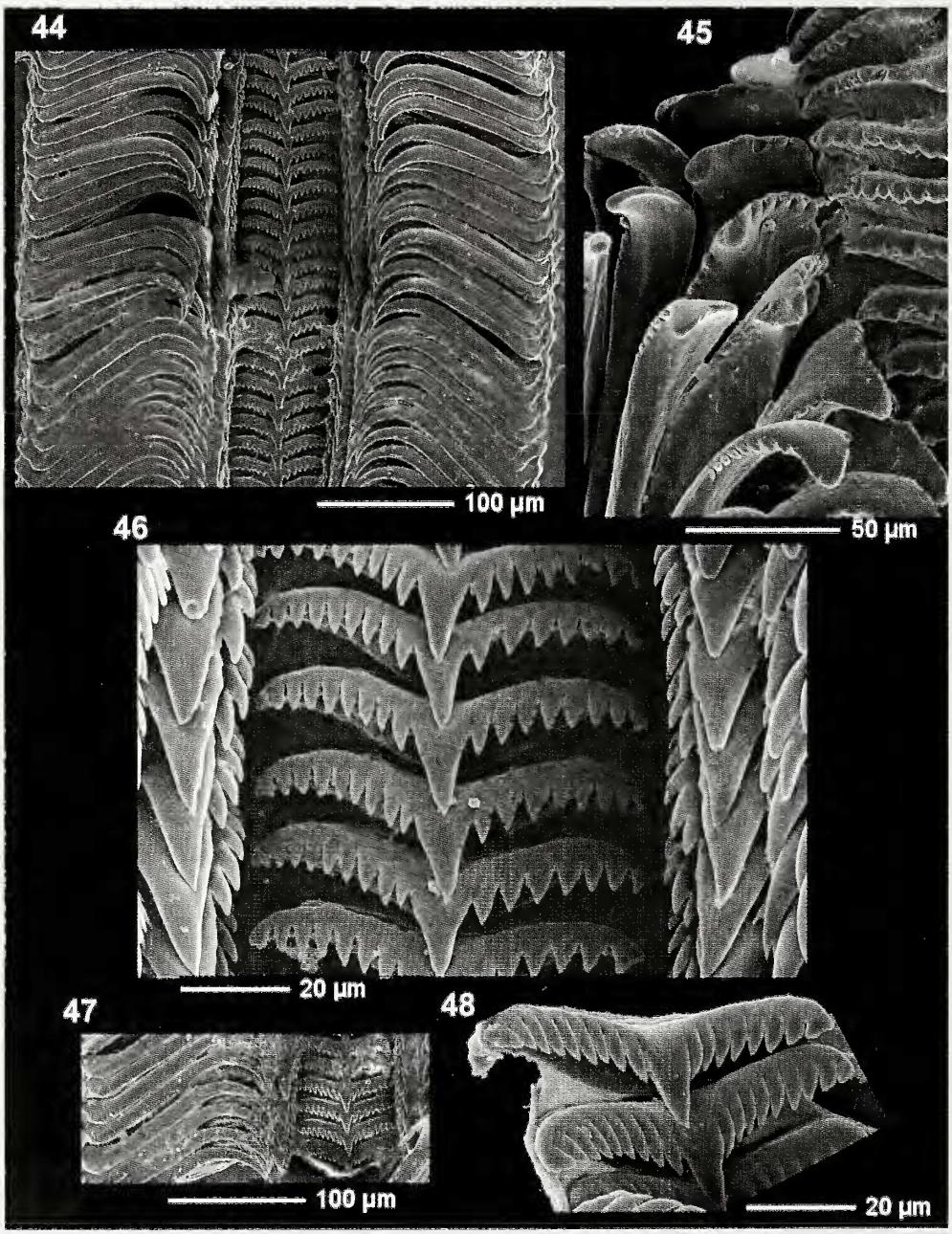
Figures 33–43. *Cheilea* species. **33–38.** *Cheilea africana* new species. **33.** Juvenile, 2.3 mm, São Tomé I. (MHNS). **34.** juvenile, 2.4 mm, Principe (MHNS). **35–38.** Protoconchs, Lagoa Azul and Esprainha, São Tomé Island. **39–41.** *Cheilea africana* new species. 39: holotype, 11 mm, Regona, Sal I., Cape Verde Archipelago (MNCN); 40: juvenile, internal face, 2.6, Miamia, Ghana; 41: juvenile, 1.3 mm, Lagoa Azul, São Tomé Island (MHNS). **42–43.** Radula of *Cheilea americana* new species, Chapéu Nordeste Island, Fernando de Noronha, Brazil.

Distribution: This is an Amphiatlantic species known from Brazil (holotype), Cuba (a juvenile), and from the islands of the Guinean Gulf (São Tomé and Annobon Is.) off the West African coast.

Remarks: *Cheilea atlantica* new species has a multispiral protoconch with more whorls than other known species and typical microsculpture not present on nucleus and on first ½ whorl, continuing with a reticulated section and ending on a distinctive section with very light sculpture. The teleoconch begins with very numerous light spiral lines. Since it the teleoconch is so variable, only the study of the protoconch allows for its conchological separation from other species. Apparently this species is living sympatrically with *Cheilea africana* in São Tomé and Annobon in West Africa and probably with *C. americana* new species in Brazil. The protoconchs of these two latter species are shorter, with only 2 and 1.75 whorls, respectively. In addition, the beginning of the protoconch of *Cheilea atlantica* new species is more sculptured.

***Cheilea africana* new species Rolán and Fernández-Garcés**
(Figures 28–41, 44–48)

Type Material: Holotype (15.05/60100, s, Figure 39) and 4 paratypes (15.05/60100, s) in MNCN, all from type locality. Paratypes in following collections: MNHN



Figures 44–48. *Cheilea africana* new species. Radula, Cape Verde Archipelago.

(IM-2012-2013, 6 s), Praia, Santhiago, Cape Verde; MHNS (100595, ex-12389, 5 s) (100595, ex-7031, 1 sp, 7 s) Mordeira, Sal Island, Cape Verde; CPR (1 s) Santa Maria, Sal Island, Cape Verde; CFG (1 s), Sal-Rei, Boavista Island, Cape Verde; MHNS (100595, 2 s, Figures 28–29), Lagoa Azul, São Tomé Island, São Tomé and Principe; CSG (6 j) Minerio, São Tomé Island, São Tomé and Principe, 41 m depth.

Type Locality: Regona, Sal Island, Cape Verde.

Other Material Examined: Senegal: 4 j, Dakar, 15 m (MHNS). Cape Verde Archipelago: 9 j, Regona, Sal I. (MHNS); 1 s, Palmeira, Sal I. 30 m (MHNS). Ghana: 6 j, Miamia, 25-35 m (MHNS). São Tomé and Principe, Principe Island: 4 j, Santo Antonio, 4-10 m (MHNS). São Tomé and Principe, São Tomé Island: 6 j, Minerio, 35–41 m (MHNS); 6 j, Lagoa Azul, 15 m (MHNS); 1 s, Esprainha, 8 m (MHNS). Annobon: 1 j, San Antonio de Palé, 5 m (NHNS).

Etymology: The species is named after the continent where the species was collected.

Description: Shell very irregular, approximately conical, solid, dirt-whitish. Protoconch about 650 maximum diameter, with about 2 whorls; embryonic shell well-defined including: nucleus measuring 140 µm and first half-whorl with rough and very irregular sculpture with rounded depressions, following 0.25 whorl presenting about 5–6 strong spiral lines with small threads between them. Separation between these two parts is well-defined. Last 1.25 whorls are smooth and have only growth lines. As can be seen internally in juveniles (Figures 40–41), its surface originally present numerous irregular spiral lines, which later disappear as a result of erosion. Beginning of teleoconch with numerous spiral lines (about 30–35) which gradually separate: a group at each side bordering the protoconch and another continuing centrally in front of last section of last protoconch whorl. Entire external surface irregularly striated, presenting numerous elevations, shell edge very irregular, conforming to substrate irregularities. Internally part with the erect curved process, which begins under the apex and is characteristic of the genus. Soft parts not observed. Radula (Figures 44–48) with wide central teeth with very prominent central cusp and 8–9 smaller lateral cusps; lateral elongate with about 6 cusps along cutting edge, one larger, plus 2–3 smaller outward; marginal teeth elongate, with a wide and prominent cusp and many, very small lateral cusps.

Dimensions: Largest shell measures 27.8 mm; the holotype is 11 mm.

Distribution: West Africa: Cape Verde, Senegal, Ghana, São Tomé and Principe, and Annobon.

Remarks: *Cheilea africana* new species may be distinguished from *C. striata* Nowell-Usticke, 1959 as this latter species has a protoconch with less than one whorl and a wider nucleus. *Cheilea americana* new species has a very similar protoconch, but with only 1.5 whorls, with more marked, zigzag spiral lines (when not eroded); furthermore, the protoconch is 100 µm smaller in diameter. The shell is very irregular externally but the radial striae are less visible. *Cheilea atlantica* new species has a protoconch with 2.75 whorls, the diameter is larger (more than 100–150 µm difference between *C. africana* and the larger *C. atlantica*), and the protoconch sculpture is different with a nucleus and 0.5 whorl almost smooth and subsequent 1.5 whorls strongly reticulated.

Conclusions: *Cheilea equestris* (Linnaeus, 1758) has been considered as a cosmopolitan species. The present study shows that more than one taxon had been lumped under that nominal species, most of them on the basis of shell characters only. This study may encourage similar efforts for additional populations living in areas geographically removed from the type locality of the nominal species. Such efforts will inevitably reveal additional unnamed species. It seems that, if nothing else, SEM studies of protoconchs and comparison with previously known species could be a fine method of separation.

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